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Operations and Maintenance Manual for the Expanded-Scale Bioventing System at Building 8200 Fort Carson, Colorado

Prepared For

The US Army Environmental Center
Aberdeen Proving Ground, Maryland

Fort Carson
Colorado Springs, Colorado

and

Air Force Center for Environmental Excellence
Brooks Air Force Base
San Antonio, Texas

July 1997

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900 • Denver, Colorado 80290

AGM01-03-0565

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TABLES

SECTION 1

INTRODUCTION

This operations and maintenance (O&M) manual has been created as a guide for monitoring and maintaining the performance of the expanded-scale bioventing blower system at Building 8200, Fort Carson, Colorado. Record drawings for the expanded-scale bioventing system, installed at Building 8200 in May 1997 in accordance with the site remedial action plan, are provided in Appendix A of this O&M manual.

At this site, bioventing is the forced injection of fresh air to enhance the supply of oxygen to native bacteria in subsurface soils for *in situ* bioremediation of fuel hydrocarbons. A blower system is used to inject air into the soil, thereby supplying atmospheric air (with approximately 20.8 percent oxygen) to contaminated soils. Once oxygen is provided to the subsurface, indigenous aerobic bacteria biodegrade fuel residuals. Aerobic biodegradation of fuel compounds in soil is much more efficient than anaerobic biodegradation, which occurs in oxygen-depleted soils.

Parsons Engineering Science, Inc. (Parsons ES) has installed an air injection bioventing system consisting of two air injection blowers, 7 vent wells (VWs), 13 soil gas monitoring points (MPs), and associated piping at the site. The regenerative blower at Building 8200, installed in July 1996, was initially used for air injection into VW1 and VW2. During expanded-scale installation, the air injection piping for VW1 and VW2 was rerouted to a new rotary-vane blower system. The rotary-vane blower was started in May 1997, and the injection rates into each VW (VW1, VW2, VW4, VW5, VW6, and VW7) were optimized over a 21-day period to ensure adequate aeration of contaminated soils. The regenerative blower is now used for air injection into the newly constructed horizontal VW (VW3) that is located within the former tank excavation.

Fort Carson Directorate of Environmental Compliance and Management (DECAM) personnel located at Fort Carson are responsible for routine monitoring of the bioventing systems. Parsons ES has trained DECAM personnel on the monitoring requirements of this plan. If significant problems are encountered with the operation of the system, Parsons ES should be notified so repairs can be made. Under the Air Force Center for Environmental Excellence (AFCEE) Extended Bioventing Project Option 1 scope of work, Parsons ES is responsible for system repair for a 1-year period after system startup (i.e., until May 1998). Should the bioventing system cease to operate or develop significant problems, please call the Parsons ES Site Manager, Mr. Dave Teets, at (303) 831-8100.

SECTION 2

SYSTEM DESCRIPTION

2.1 Blower Systems

A Gast® 6066-P122-T339 rotary-vane blower powered by a 5-horsepower, direct-drive motor was installed at Building 8200. The blower is rated for a flow rate of 53 standard cubic feet per minute (scfm) at a pressure of 5 pounds per square inch (psi); however, the actual performance of the blower will vary with changing site conditions. Details of the O&M of the Gast® R5 regenerative blower installed in July 1996 are contained in the *O&M Manual for the Pilot-Scale Bioventing System at Building 8200, Fort Carson, Colorado* (Parsons ES, 1996). Table 2.1 presents the flow rate into each of the injection VWs in actual cubic feet per minute (acfm). The new blower system includes an inlet air filter to remove any particulate matter which may be entrained in the inlet air stream, a secondary air filter, and several valves and monitoring gauges, which are described in Section 2.2. An as-built schematic of the expanded-scale blower system installed at Building 8200 is shown in Appendix A. Corresponding blower performance curves and relevant service information are provided in Appendix B.

2.2 Monitoring and Flow Control Equipment

2.2.1 Monitoring Gauges and Ports

The rotary-vane blower system is equipped with one vacuum gauge, one pressure gauge, and one temperature gauge. The vacuum gauge is located on the inlet piping between the air filter and the blower, and the temperature and pressure gauges are located on the outlet piping. Each individual VW manifold pipe has one air velocity measurement port (i.e., each VW has its own individual flow measurement port). Refer to the record drawings in Appendix A for exact gauge and port locations.

2.2.2 Flow Control Equipment

Manual and automatic pressure relief valves (PRVs) and flow control valves (FCVs) have been installed on the bioventing blower system. A manual FCV, or bleed valve, has been installed in the outlet piping leading to each VW, allowing the flow rate to each VW to be manually adjusted. An automatic FCV, or PRV, is used to protect the blower system from burning out if pressure rises due to pipe blockage. The PRV is set to bleed off air flow at a preset pressure, and thus will prevent blower outlet pressures from exceeding the rated pressure.

TABLE 2.1
INITIAL AND FINAL AIR FLOW RATES
BUILDING 8200
FORT CARSON, COLORADO

Rotary-Vane Blower

Monitoring Location	Initial Air Velocity (fpm[a/])	Initial Flow Rate (acfm[b/])[c/]	Final Air Velocity (fpm)	Final Flow Rate (acfm)[d/]
FCMW89/VW1	1,000	5.4	575	3.1
VW2	425	2.3	575	3.1
FCMW88/VW4	325	1.8	350	1.9
VW5	1,000	5.4	1,200	6.5
VW6	360	1.9	600	3.2
VW7-Shallow	1,000	5.4	975	5.3
VW7-Deep	950	5.1	1,200	6.5
Total Blower Output		27.3		29.6

Regenerative Blower

Monitoring Location	Initial Air Velocity (fpm)	Initial Flow Rate (acfm)[e/]	Final Air Velocity (fpm)[f/]	Final Flow Rate (acfm)[g/]
VW3	0	0.0	1,500	32.7
Total Blower Output		0.0		32.7

[a/] fpm = feet per minute. Pipe diameter = 1 inch.

[b/] acfm = actual cubic feet per minute.

[c/] Rotary-vane blower performance on May 14, 1997: Pressure= 6.5 pounds per square inch (psi). Vacuum and temperature gauges not installed.

[d/] Rotary-vane blower performance on June 4, 1997: Pressure= 5.6 psi; Vacuum= 10 "H_2O; Temperature = 176 degrees Fahrenheit.

[e/] Power to the regenerative blower was not available.

[f/] Pipe diameter = 2 inches.

[g/] Regenerative blower performance on June 4, 1997: Pressure= 9.5 "H_20; Vacuum= 10 "H_2O; Temperature = 106 degrees Fahrenheit.

An additional FCV (bleed valve) has been installed to control the total air flow out of the blower by releasing excess air flow to the atmosphere. All of the FCVs have been set by Parsons ES personnel to deliver a calculated amount of air to each VW, and should not be adjusted.

As discussed in Section 2.2.1, each manifold pipe leading to an individual VW has also been equipped with a flow measurement port. These ports consist of brass bushings installed in the outlet piping inside the blower shed. These bushings, which should be capped during system operation, allow the insertion of a thermal anemometer for the measurement of air velocity. These ports are used to measure the flow of air into each individual VW, and should not be adjusted or utilized by unauthorized personnel.

SECTION 3

SYSTEM MAINTENANCE

Although the rotary-vane blower system installed at Building 8200 is relatively maintenance free, periodic system maintenance is required to ensure proper operation and long life. Recommended maintenance procedures and schedule are described in detail in the manufacturers' instruction manuals included in Appendix B and briefly summarized in this section.

3.1 Blower/Motor

The blower and motor are relatively maintenance free and should not require any maintenance during the operational period. Both the blower and motor have sealed bearings and do not require lubrication.

3.2 Air Filter

To avoid damage caused by passing solids through the blower, a primary air filter has been installed in-line before the blower. The paper filter element is accompanied by a polyurethane foam prefilter. The filters should be checked weekly for the first 2 months of operation. Based on the first 2 months of system monitoring, a facility employee should be able to determine the best schedule for filter replacement. The polyurethane prefilters can be washed with lukewarm water and a mild detergent. Paper filter elements should never be washed, and should be disposed of and replaced as necessary. When the pressure or vacuum drop across the filter is 15 inches of water or greater, a dirty filter element should be suspected, and cleaning or replacement should be performed. Typical filter element replacement intervals range from 3 to 6 months.

To remove the filter:

1. Turn the system off by turning the breaker off,
2. Loosen the wing nut on the filter top,
3. Lift the metal top off the air filter; and
4. Lift the air filter element from the metal housing.

Remove the polyurethane prefilter (if applicable) and wash before replacing. If the paper element is not appreciably clogged, the prefilter may be washed and replaced around the paper element. The entire filter unit is then installed by reversing steps 2

through 4. The secondary air filter will not require any maintenance. After the filter has been washed and/or replaced, restart the blower by turning the breaker on. Do not adjust any of the FCVs during the filter changing procedure; they have been set by Parsons ES personnel to deliver a calculated volume of air to each individual VW. Altering FCV setting may unbalance the system and greatly reduce the effectiveness of the remedial technology.

The filter element is manufactured by Gast Manufacturing Corporation in Benton Harbor, Michigan. Their telephone number is (616) 926-6171. The part number for the replacement paper filter element is AJ134E. Spare air filter elements have been placed inside the blower enclosure.

3.3 Maintenance Schedule

The following maintenance schedule is recommended for the blower system. During the initial few months of operation, more frequent monitoring is recommended to ensure that any startup problems are quickly corrected. A daily drive-by inspection is recommended during the initial 2 weeks of operation to ensure that the blower system is operating normally. Thereafter, monitoring inspections every 2 weeks are recommended (see Section 4). Preprinted data collection sheets have been provided to facility personnel. Extra data collection sheets for recording maintenance activities are provided in Appendix C.

Maintenance Item	Maintenance Frequency
Filters	Check once every 2 weeks, wash prefilter and/or replace paper filter as necessary (see Section 3.2). Inlet vacuum exceeding 15 inches of water indicates that the filters require cleaning or replacement.

3.4 Major Repairs

Blower systems are very reliable when properly maintained. Occasionally, however, a motor or blower will develop a serious problem. If a blower system fails to start, and a qualified electrician verifies that power is available at the blower or starter, Parsons ES should be contacted to arrange for repairs. The Parsons ES contact is Mr. Dave Teets at (303) 831-8100. Parsons ES is responsible for major repairs during the first year of operation.

SECTION 4

SYSTEM MONITORING

4.1 Blower Performance Monitoring

To monitor the performance of the blower, the inlet vacuum, outlet temperature and outlet pressure should be measured at the blower. These data should be recorded every 2 weeks on a data collection sheet (provided in Appendix C). All measurements should be taken at the same time, while the system is running. Because the blower is noisy, hearing protection should be worn at all times.

4.1.1 Vacuum

With hearing protection in place, unlock and open the blower enclosure and record the vacuum directly from the gauge (in inches of water). Record the measurement on the data collection sheet.

4.1.2 Temperature

With hearing protection in place, unlock and open the blower enclosure and record the temperature directly from the gauge in degrees Fahrenheit (°F). Record the measurement on the data collection sheet (provided in Appendix C). The temperature change can be converted to degrees Celsius (°C) using the formula °C= (°F - 32) X 5/9.

4.1.3 Pressure

With hearing protection in place, unlock and open the blower enclosure and record the main blower pressure (in psi) from the pressure gauge located on the blower outlet piping next to the temperature gauge.

4.2 Monitoring Schedule

During the initial month of operation, more frequent monitoring is recommended to ensure that any start up problems are quickly corrected. The following monitoring schedule is recommended for this system.

Monitoring Item	Monitoring Frequency
Vacuum/Pressure	Once every 2 weeks.
Temperature	Once every 2 weeks.

APPENDIX A

RECORD DRAWINGS

RECORD DRAWINGS FOR

EXPANDED BIOVENTINGS SYSTEM
BUILDING 8200
FORT CARSON

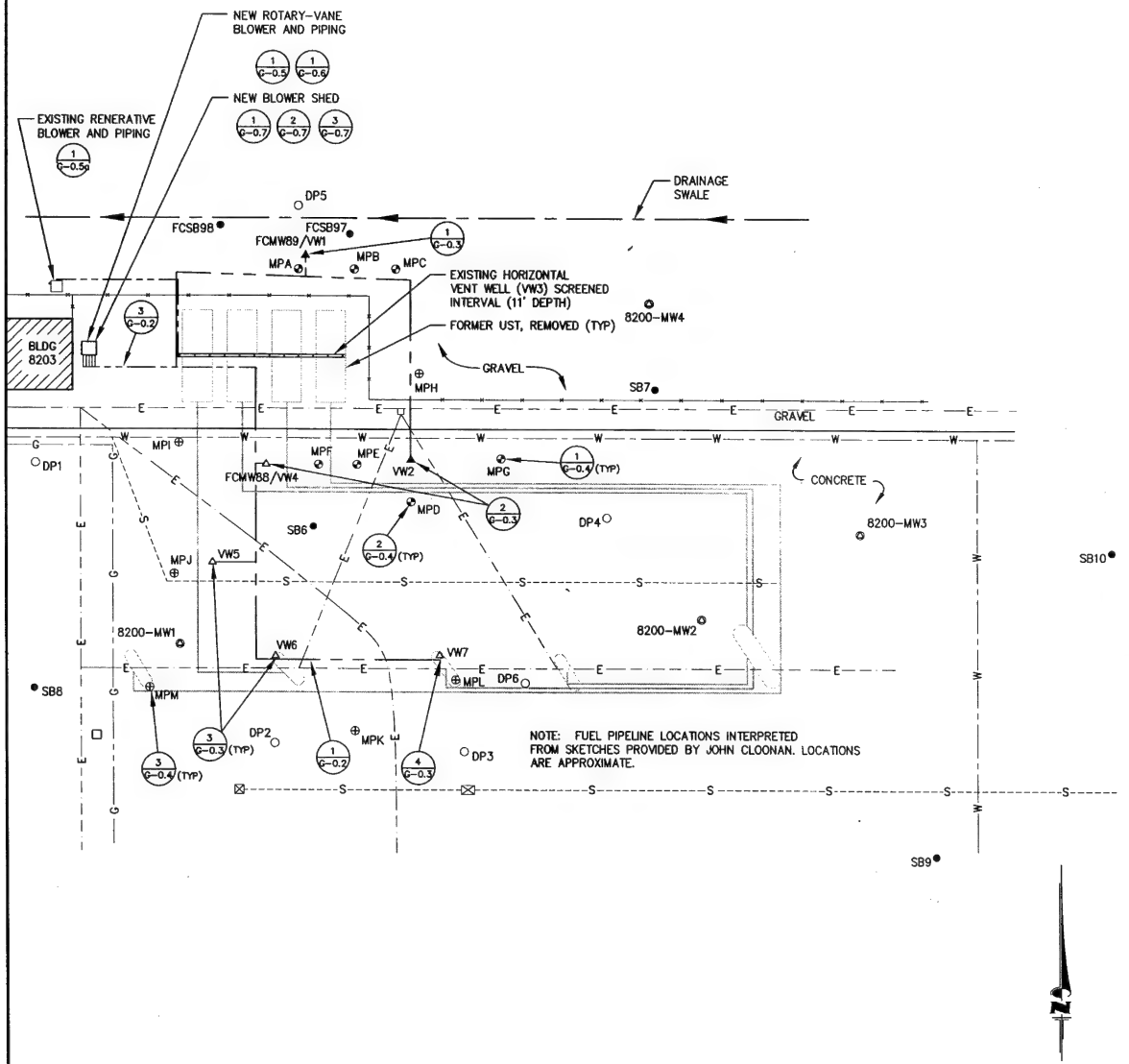
PREPARED FOR

AFCEE
AND USAEC

JUNE 1997

DRAWING INDEX

DRAWING NO	
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAILS
G-0.3	VENT WELL STANDARD DETAILS
G-0.4	MONITORING POINT STANDARD DETAILS
G-0.5	ROTARY-VANE BLOWER P & ID
G-0.5a	REGENERATIVE BLOWER P & ID
G-0.6	ROTARY-VANE BLOWER PIPING LAYOUT DETAIL
G-0.7	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS



SITE LAYOUT

SCALE: 1" = 40'

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Drawn RSM					
Checked DPS					
Reviewed					
Approved					
Reg. No.			1	6/30/97	Record Drawing
Date			Rev	Date	Description

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Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
BUILDING 8200
FORT CARSON

TITLE SHEET AND SITE LAYOUT

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G-0.1	1

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ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
&	AND
@	AT
BLDG	BUILDING
CBM	CENTER BACK MOUNT
DIA	DIAMETER
E	ELECTRICAL
eg	FOR EXAMPLE
FPT	FEMALE PIPE THREAD
FT	FOOT
G	GAS
GALV	GALVANIZED STEEL
HDPE	HIGH-DENSITY POLYETHYLENE
LM	LOWER MOUNT
MAX	MAXIMUM
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
PSI	POUNDS PER SQUARE INCH
REF	REFERENCE
SCH	SCHEDULE
S	SEWER
SPVC	SLOTTED POLYVINYL CHLORIDE
ST	STORM SEWER
ST STL	STAINLESS STEEL
TYP	TYPICAL
UE	UNDERGROUND ELECTRIC
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W	WATER
W/	WITH
WWF	WELDED WIRE FABRIC

SYMBOLS

- 8200-MW1 — EXISTING GROUNDWATER MONITORING WELL
- MPA — EXISTING BIOVENTING MONITORING POINT
- VW1 — EXISTING VENT WELL
- SB6 — PREVIOUS SOIL BORING
- DP1 — PREVIOUS DIRECT PUSH SOIL/WATER SAMPLING LOCATION
- MPH — NEW BIOVENTING MONITORING POINT
- VW4 — NEW VENT WELL
- HEADER PIPE TO VENT WELL
- FENCE

SECTION DESIGNATION (A / X) — SECTION NAME: **SECTION CUT** — SCALE: NTS — DRAWING OF ORIGIN — SCALE

DETAIL NO (1 / X) — DETAIL NAME: **DETAIL DESCRIPTION** — SCALE: NTS — DRAWING OF ORIGIN — SCALE

MATERIAL LEGEND

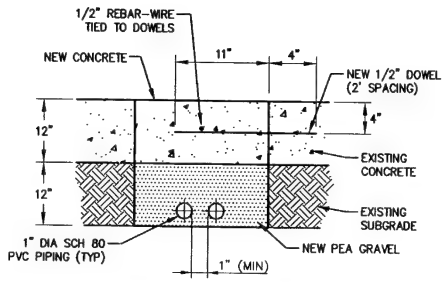
- ASPHALT
- BENTONITE
- BENTONITE/CEMENT GROUT
- BENTONITE PELLETS
- BUILDING (EXISTING)
- COMPACTED BACKFILL
- COMPACTED BASE STONE
- CONCRETE
- PEA GRAVEL
- SAND
- UNDISTURBED SOIL

PIPE MATERIAL

GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

PIPE SERVICE

AIJ	AIR INJECTION



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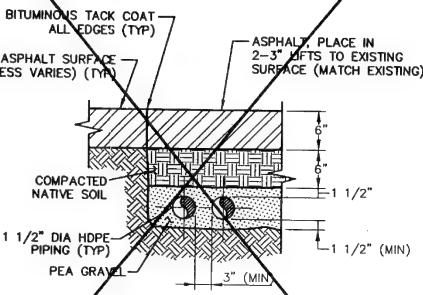

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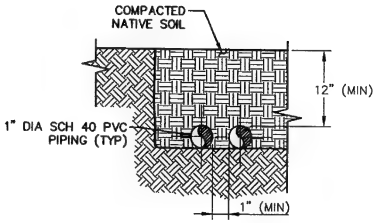

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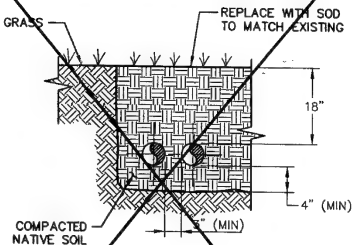

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Approved					7/17/97	
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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM BUILDING 8200 FORT CARSON

LEGEND AND STANDARD TRENCH DETAILS

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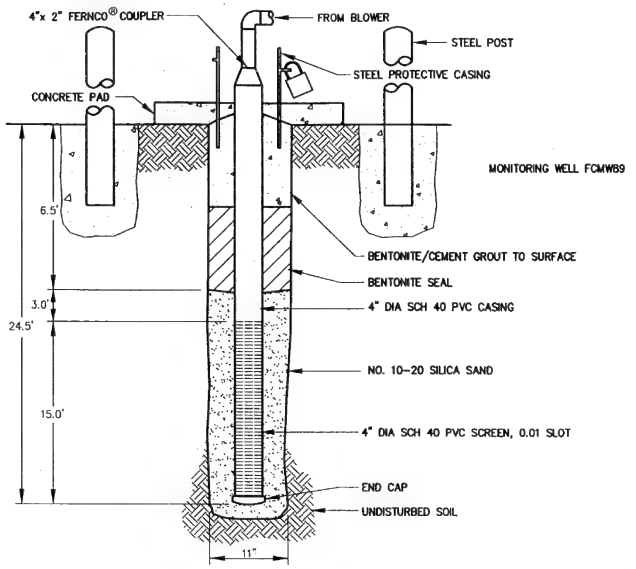

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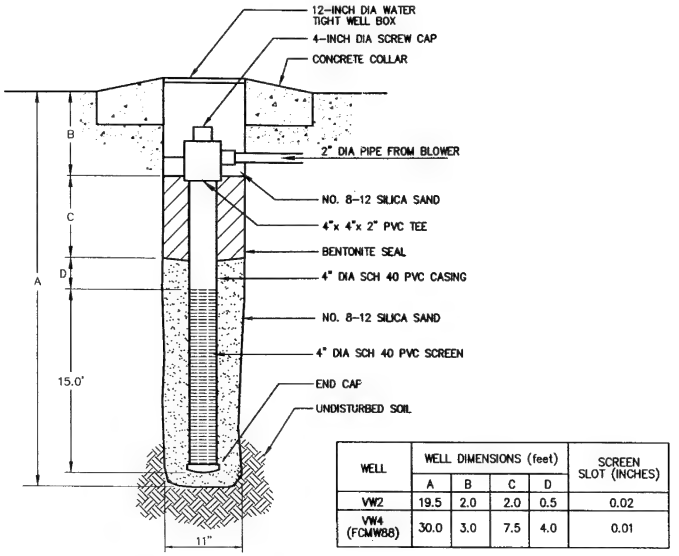

WELL	WELL DIMENSIONS (feet)				SCREEN SLOT (INCHES)
	A	B	C	D	
VW2	19.5	2.0	2.0	0.5	0.02
VW4 (FCMW88)	30.0	3.0	7.5	4.0	0.01

2 — VW2 AND VW4 DETAIL

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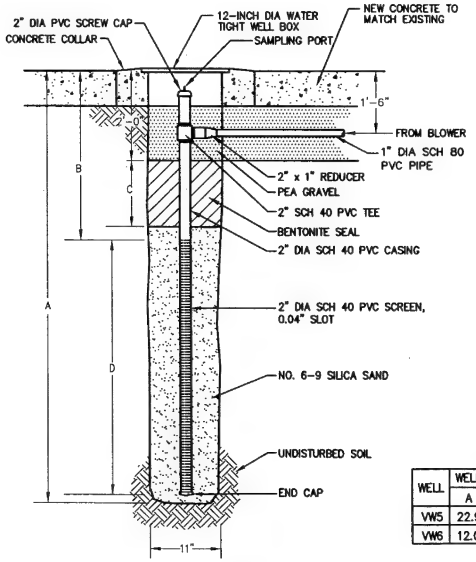

WELL	WELL DIMENSIONS (feet)			
	A	B	C	D
VW5	22.9	12.9	10	10
VW6	12.0	4.9	2.5	5

3 — VW5 AND VW6 DETAIL

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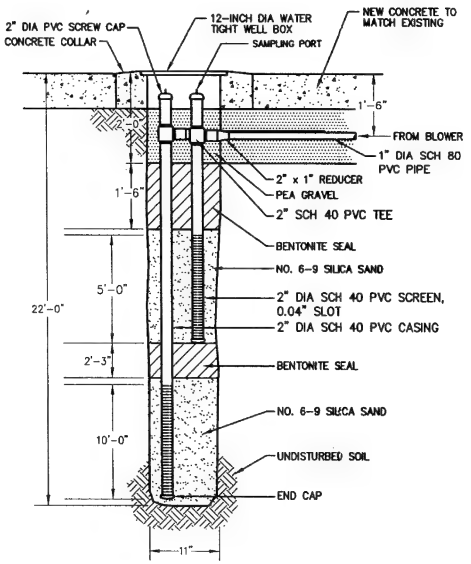

4 — VW7 DETAIL

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Checked DBT 7/1/97
Reviewed
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Date

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EXPANDED BIOVENTING SYSTEM
BUILDING 8200
FORT CARSON

VENT WELL
STANDARD DETAILS

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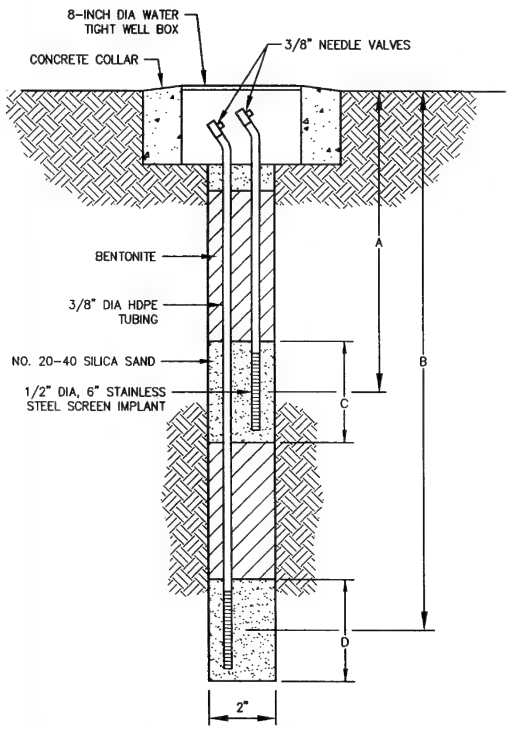

MONITORING POINT	DEPTH TO SCREEN INTERVALS (ft bgs)a/		SAND PACK THICKNESS (ft)	
	A	B	C	D
MPA	16.0	19.0	1.0	1.0
MPB	15.5	20.0	1.0	1.0
MPC	15.0	23.0	2.0	2.0
MPG	13.0	22.0	2.0	5.0
MPH	12.0	20.5	7.0	5.0

a/ ft bgs = feet below ground surface

1 MONITORING POINT (MP) DETAIL

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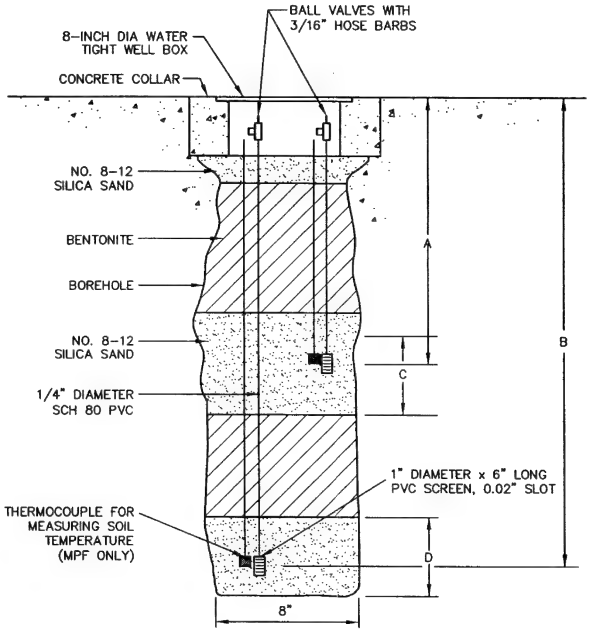
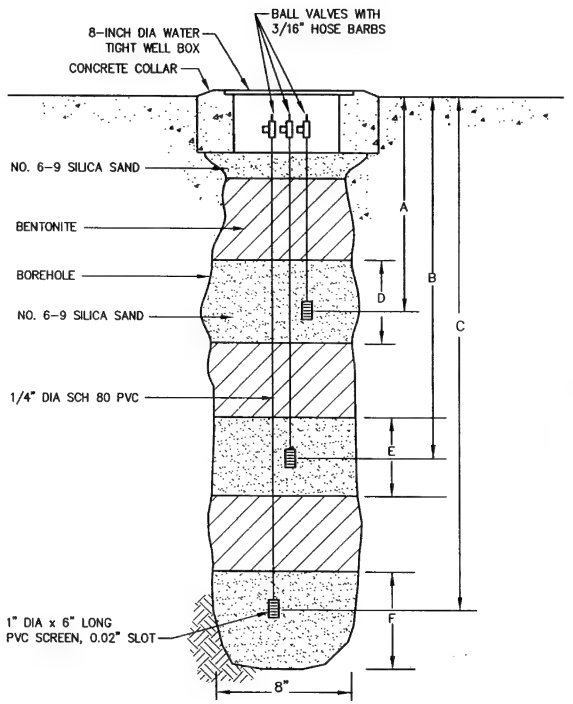


MONITORING POINT	DEPTH TO SCREEN INTERVALS (ft bgs)a/		SAND PACK THICKNESS (ft)	
	A	B	C	D
MPD	10.0	18.0	4.0	4.5
MPE	7.0	11.0	2.0	2.5
MPF	12.0	16.0	2.0	2.0

a/ ft bgs = feet below ground surface

2 MP DETAIL

SCALE: NTS



MONITORING POINT	DEPTH TO SCREEN INTERVALS (ft bgs)a/			SAND PACK THICKNESS (ft)		
	A	B	C	D	E	F
MPI	11.3	16.4	NA b/	4	5	NA
MPJ	10.8	19.8	NA	5	7	NA
MPK	4.8	NA	NA	2	NA	NA
MPL	10.2	15.8	22.3	4	4	5
MPM	5.5	10.2	NA	3	3	NA

a/ ft bgs = feet below ground surface
b/ NA= Not Applicable

3 MP DETAIL

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Date			

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
BUILDING 8200
FORT CARSON

MONITORING POINT STANDARD DETAILS

DRAWING NO: G-0.4
REV: 1

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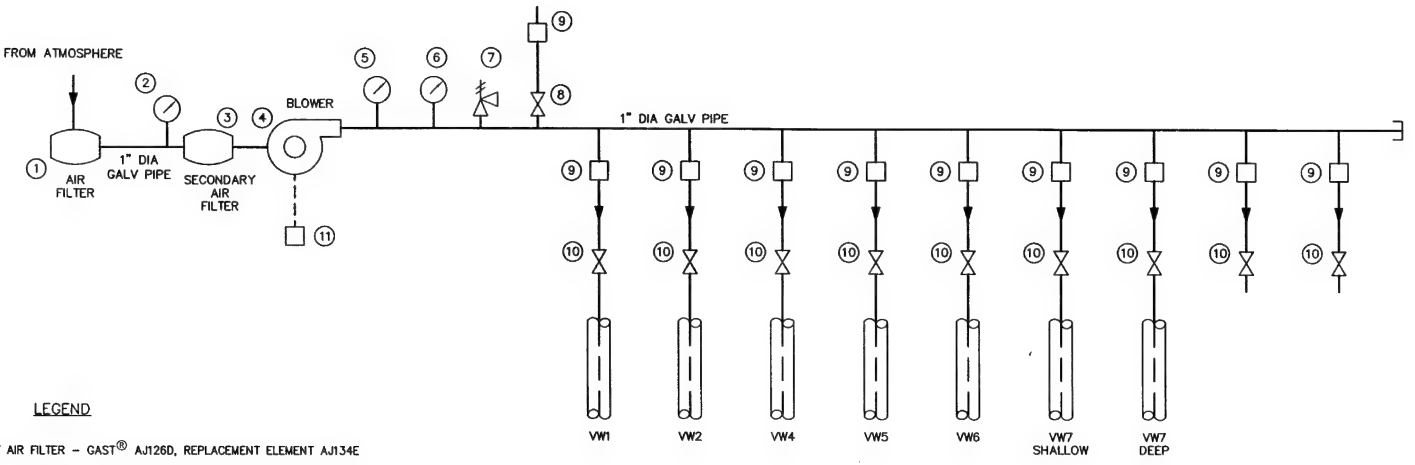

LEGEND

(1) INLET AIR FILTER – GAST® AJ126D, REPLACEMENT ELEMENT AJ134E

(2) VACUUM GAUGE, GAST® AJ497 2 3/4" DIA., 0–60" H_2O 1/4" NPT, LM

(3) SECONDARY AIR FILTER – GAST® AD560, REPLACEMENT ELEMENT AD752

(4) BLOWER – GAST® 5.0 HP 6066–P122–T339, 53 CFM AT 5 PSI

(5) PRESSURE GAUGE – GAST® AA644B, 2" DIA., 0–30 PSI, 1/4" NPT, LM

(6) TEMPERATURE GAUGE – ASHCROFT, 0–250°F, 1/2" NPT, CBM (Part No. 2A606 FROM GRAINGER)

(7) AUTOMATIC PRESSURE RELIEF VALVE – GAST® AA307, ADJUSTABLE, 2–25 PSI PRESSURE

(8) MANUAL PRESSURE RELIEF (BLEED) VALVE – 1" GATE

(9) FLOW MEASURING PORT FITTED WITH PLUG (1/4"x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)

(10) FLOW CONTROL VALVE – 1" GATE

(11) STARTER AND FUSED DISCONNECT SWITCH

1/– ROTARY–VANE BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

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Job No. 726876.73340					
Designed DBT					
Drawn RSM					
Checked DBT	7/1/97				
Reviewed	7/1/97				
Approved					
Reg. No		1	6/30/97	Record Drawing	
Date		Rev	Date	Description	By

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

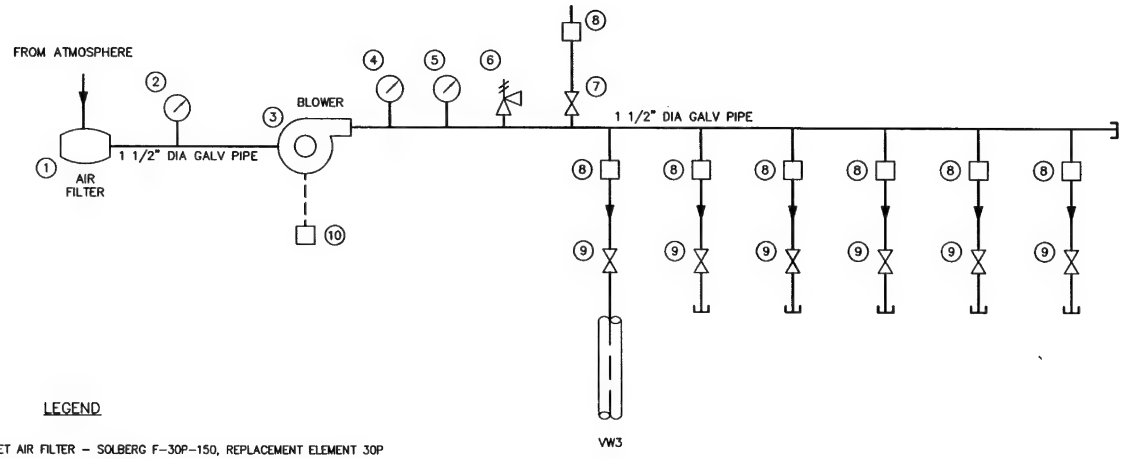
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
BUILDING 8200
FORT CARSON

ROTARY-VANE BLOWER P & ID

DRAWING NO G-0.5

REV 1



LEGEND

(1) INLET AIR FILTER – SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P

(2) VACUUM GAUGE –GAST® AJ497, 2 1/2" DIA, 0–60" H_2O, 1/4" NPT, LM

(3) BLOWER – GAST® 2.0HP R5125Q-50, 140 CFM AT 20" H_2O PRESSURE

(4) TEMPERATURE GAUGE – ASHCROFT, 0–250°F, 1/2" NPT, CBM
(Part No. 2A606 FROM GRAINGER)

(5) PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA., 0–100" H_2O, 1/4" NPT, LM
(Part No. 9851810)

(6) AUTOMATIC PRESSURE RELIEF VALVE – GAST® AG258, SET TO RELEASE AT 45" H_2O PRESSURE

(7) MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE

(8) FLOW MEASURING PORT FITTED WITH PLUG (1/4" x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)

(9) FLOW CONTROL VALVE – 1 1/2" GATE

(10) STARTER

1/– REGENERATIVE BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

Job No. 726876.7334C
Designed DBT
Drawn RSM
Checked DBT
Reviewed
Approved
Reg No
Date

Rev	Date	Description	By
1	6/30/97	RECORD DRAWING	

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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
BUILDING 8200
FORT CARSON, COLORADO

REGENERATIVE BLOWER P & ID

DRAWING NO G-0.5a | REV 1

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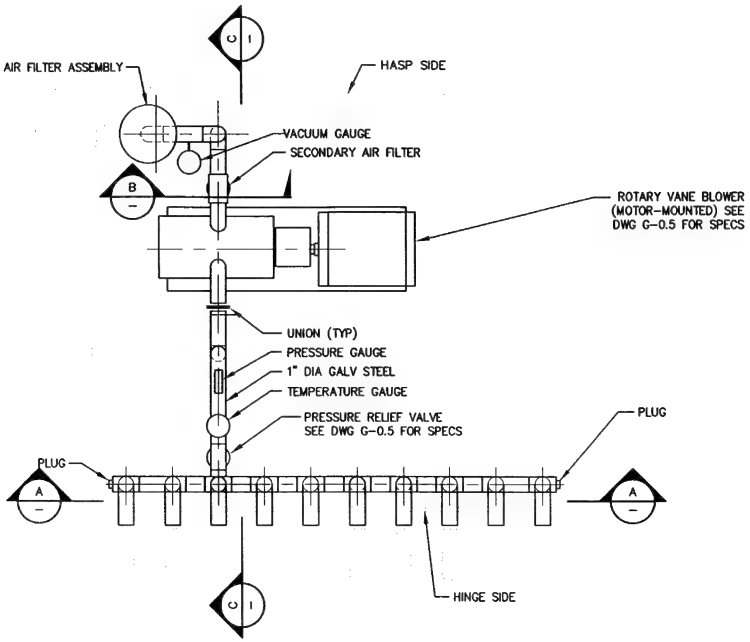
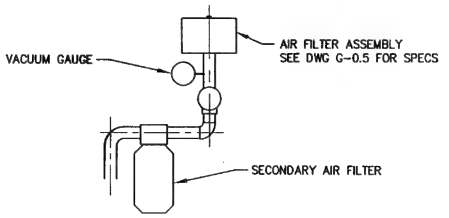


1 BLOWER PIPING LAYOUT PLAN DETAIL

3/4" = 1'-0"

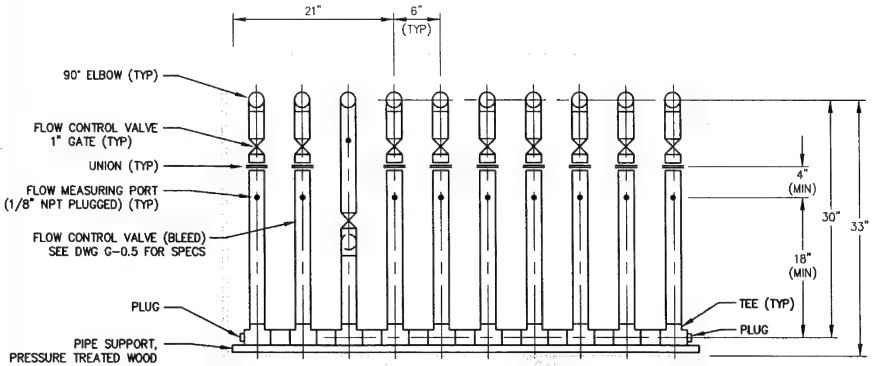
NOTES:

1. ALL PIPING 1" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
2. SEE DRAWING G-0.7 FOR BLOWER BUILDING DETAILS



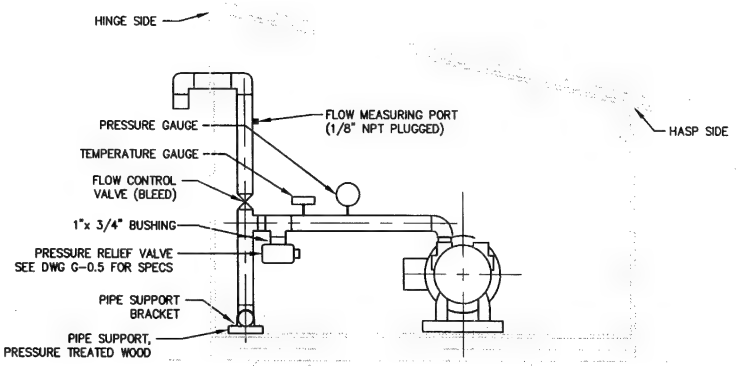
B BLOWER INLET PIPING SECTION

3/4" = 1'-0"



A MANIFOLD DETAIL SECTION

3/4" = 1'-0"



C BLOWER OUTLET PIPING SECTION

3/4" = 1'-0"

By	Description	Date
	Record Drawing	6/30/97

Job No. 726876.73340
Designed DBT
Drawn RSN
Checked DBT 7/1/97
Reviewed [illegible] 7/1/97
Approved [illegible]
Reg No
Date

Rev. 1

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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
BUILDING 8200
FORT CARSON

ROTARY-VANE BLOWER PIPING LAYOUT DETAIL

DRAWING NO G-0.6

REV 1

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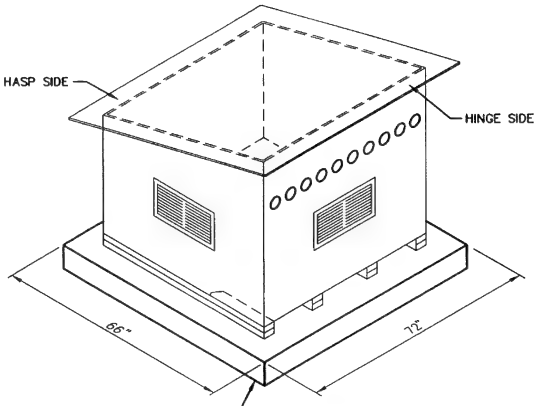
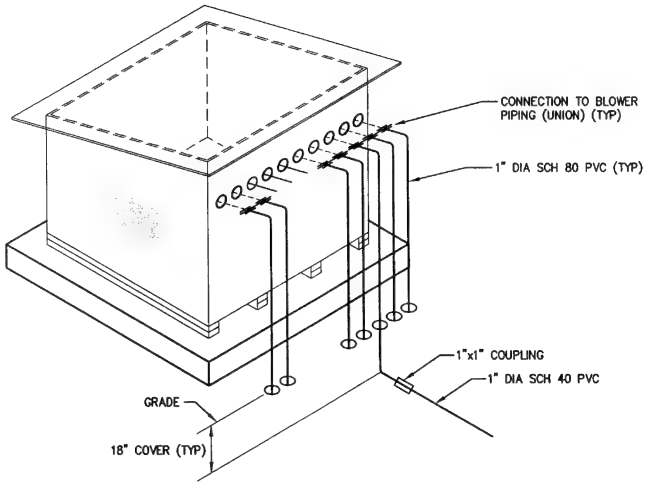


NOTES:
1. BUILDING INSTALLED CENTRAL ON CONCRETE SLAB WITH ORIENTATION AS SHOWN

CONCRETE SLAB;
6" THICK – 2500 PSI W/6"x 6" WWF
POURED ON COMPACTED OR UNDISTURBED
BASE – 1"x 45 CHAMFER TOP EDGE CONT.

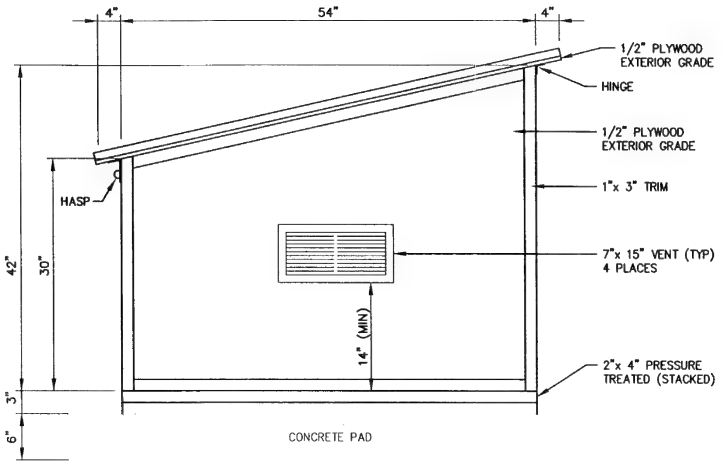
1/– BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE

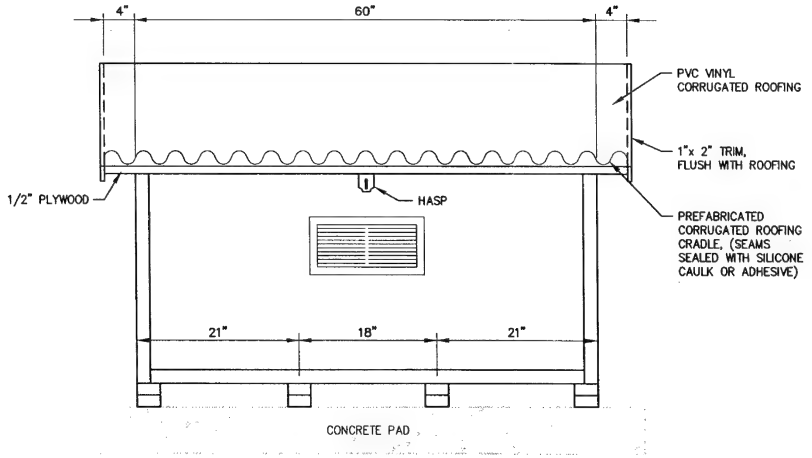


2/– TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

NOT TO SCALE



SIDE ELEVATION



FRONT ELEVATION

NOTES:
1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

3/– BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

By	Description	Date	Rev
	Recad Drawing	6/30/97	1

Job No. 726876.7334G
Designed DBT
Drawn RSM
Checked DBS 7/10/97
Reviewed 7/11/97
Approved [illegible]
Reg No. [illegible]
Date

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
BUILDING 8200
FORT CARSON

BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

DRAWING NO G-0.7

REV 1

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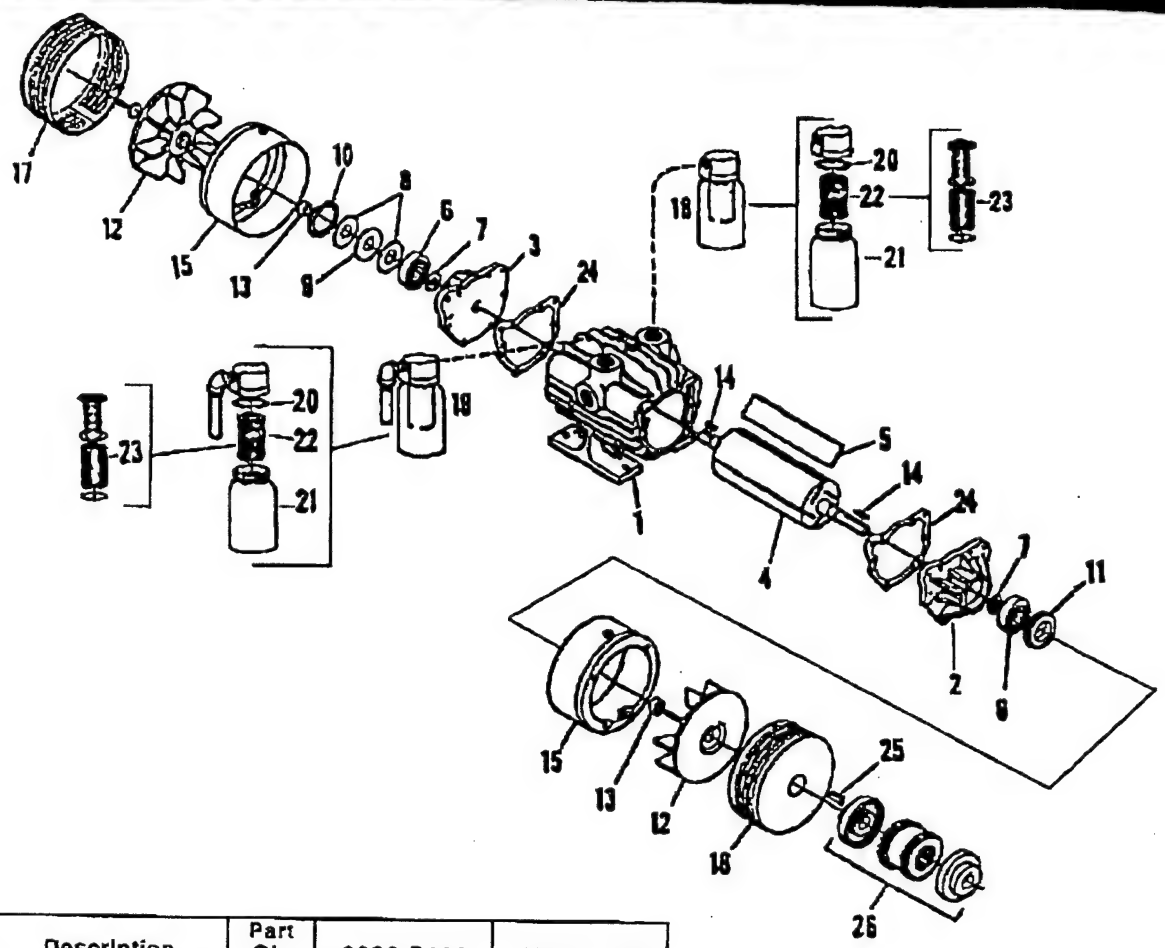
APPENDIX B

ROTARY-VANE BLOWER INFORMATION

6066 PARTS ORDERING INFORMATION



Ref. No.	Description	Part Qty	6066-P102	6066-V103
1	Body	1	AC309	AC309
2	End Plate, Drive	1	AE293	AE293
3	End Plate, Dead	1	AE294	AE294
4	Rotor Assembly	1	AE295A	AE295A
♦5	Vane	4	AK738	AK738
♦6	Bearing	2	AB964B	AB964B
7	Bearing Shoulder Ring	2	AB926T	AB926T
8	Belleville Spring	2	AB791	AB791
9	Shim Washer	1	AB792	AB792
10	Retaining Ring	1	AB793	AB793
11	End Cap	1	AB790	AB790
12	Fan	2	AK735	AK735
13	Fan Spacer	2	AE299	AE299
14	Square Key	2	AB136A	AB136A
15	Shroud	2	AE300A	AE300A
16	Fan Guard Asmb., Drive	1	AK736	AK736
17	Fan Guard Asmb., Dead	1	AK737	AK737
18	Intake Filter Assembly	1	AD560	AD560
19	Muffler Assembly	1		AD560B
♦20	Cover Gasket	1 2	AD562	AD562
21	Jar	1 2	AD563A	AD563A
22	Filter Element Assembly	1 2	AD750	AD750
♦23	Filter Felt	1 2	AD752	AD752
24	Body Spacer	1 2	AE315B	AE315B
25	Key, Coupling	1	AB136D	AB136D
26	Coupling Assembly	1	AE765	AE765
27	Check Valve (not shown)	1	AH326B	AH326B
	Service Kit	1	K603	K603

♦ Denotes parts included in the service kit.
Parts listed are for stock models. For specific OEM models, consult the factory.
When corresponding or ordering parts, please give model and serial numbers.

This is the hazard alert symbol: ⚠ When you see this symbol, be aware that personal injury or property damage is possible. The hazard is explained in the text following the symbol. Read the information carefully before proceeding.

The following is an explanation of the three different types of hazards:

⚠ **DANGER** Severe personal injury or death will occur if hazard is ignored.

⚠ **WARNING** Severe personal injury or death can occur if hazard is ignored.

⚠ **CAUTION** Minor injury or property damage can occur if hazard is ignored.

GENERAL INFORMATION

This pump is only to be used for the purpose of pumping air and under no circumstances be used with any other gases. The pump must not be used for the pumping of fluids, particles, solids or any substance mixed with air, particularly combustible substances likely to cause explosions.

⚠ **DANGER** Do not pump flammable or explosive gases or operate the unit in an atmosphere containing them.

⚠ **CAUTION** The exhaust air of this pump can become very hot. Do not direct exhaust air towards property that is temperature sensitive.

⚠ **CAUTION** The pump is designed for air only. Do not allow corrosive gases or particulate material to enter the pump. Water vapor, oil-based contaminants, or other liquids must be filtered out.

Ambient temperature should not exceed 40C (104°F). For operation at high temperatures, consult the factory.

Performance is reduced by low atmospheric pressure found at high altitudes. Consult a Gast distributor for details.

Never lubricate this oil-less rotary vane pump. The sealed bearings are grease-packed. The service life of the carbon vanes will be reduced by petroleum or hydrocarbon products.

INSTALLATION

⚠ **CAUTION** Do not lift the unit by the fan shrouds. The unit should be lifted by means of the eye bolt.

⚠**WARNING** To avoid risk of electrocution do not use this product in an area where it could come in contact with water or other liquids. If exposed to the elements it must be weather protected.

⚠ **CAUTION** Do not block the flow of cooling air over the pump in any way.

⚠**WARNING** Some models are equipped with glass jars. Proper measures should be taken to guard against the fragmenting or braking of glass if an alternative material is not used. If hazard is ignored severe personal injury or death can occur.

MOUNTING THE PUMP

The pump may be installed in any orientation as long as the flow of cool, ambient air over the pump is not blocked. To reduce noise and vibration, mount to a stable, rigid operating surface.

PLUMBING

To prevent air flow restriction, use pipe and fittings that are the same size or larger than the threaded ports of the pump. The ports are marked "IN" and "OUT".

ACCESSORIES

Intake and exhaust filters are external to the pump and will provide adequate filtration for most applications. Check filters periodically and replace when necessary. Consult a Gast Representative for additional filter recommendations. Install relief valves and gauges at the inlet or outlet, or both, to monitor performance. Check valves may be required to prevent backstreaming through the pump.

WIRING

⚠**WARNING** Incorrect wiring can result in electric shock. Wiring must conform to all required safety codes and be installed by a qualified person. Grounding is required. All power to the motor must be de-energized and disconnected when servicing.

ELECTRIC MOTOR CONTROL

The motor must be protected against short circuit, overload and excessive temperature rise. Fuses, motor protective switches and thermal protective switches provide the necessary protection in these circumstances. Fuses only serve as a short circuit protection of the motor (wiring fault). Fuses in the incoming line should be chosen so as to be able to withstand the starting current of the motor, not as a protection against overload. Motor starters, incorporating thermal magnetic overload or circuit breakers protect the motor from overload or reduced voltage conditions. Selection of the correct overload setting is required to provide the best possible protection. Refer to the motor starter manufacturer's recommendations.

ELECTRIC MOTOR CONNECTION

Refer to the motor nameplate for wiring diagram. If the motor fails to start or slows down under load, shut the pump off and unplug. Check that the supply voltage agrees with the motor nameplate. Be sure the three phase motor turns in the proper direction of rotation after installation. Turning in the wrong direction will drastically reduce vane life.

OPERATION

⚠WARNING Solid or liquid material exiting the unit can cause eye or skin damage. Keep away from air stream.

⚠WARNING Always disconnect the power before servicing. The motor may be thermally protected and will restart automatically when it cools if the thermal protection switch is tripped.

⚠WARNING Do not operate without both the coupling guard and shroud in place. Failure to do so could result in severe personal injury.

⚠ CAUTION Do not operate units above recommended pressures or vacuum duties. To do so will damage the unit.

⚠WARNING Beware of any exposed and/or movable part. Proper guards should be in place to prevent personal and/or property damage.

STARTING

If the pump is extremely cold, let it warm up to room temperature before starting. If the pump does not operate properly, see the troubleshooting guide.

⚠WARNING Some of these models may exceed 85 dB(A). When in close proximity to these models hearing protection is required. See Technical Data Sheet (if provided), for specific model(s).

MAINTENANCE AND INSPECTION

Regular inspection can prevent unnecessary damage and repairs. The intake and exhaust filters require periodic inspection and replacement. Initial inspection is suggested at 500 hours, then the user should determine the frequency. Most problems can be prevented by keeping filters clean. Dirty filters decrease pump performance and can decrease pump service life.

FILTER INSPECTION AND REPLACEMENT

⚠WARNING The pump surfaces may become very hot during operation. Do not touch these parts until the pump has been turned off and allowed to cool.

Refer to the proper exploded view during the following procedure.

With the pump turned off and isolated from power supply, and all pressure and vacuum is released from the pump, remove the felts from the intake and exhaust filters and wash them in a solvent. When clean and dry, replace them.

FLUSHING

Flushing of the pump is accomplished by removing the filter assemblies and while the pump is running, add several tablespoons or spray solvent directly into the intake port. Recommeded is Gast flushing solvent part number AH255B.

⚠WARNING Do not use kerosene, gasoline or any flammable liquid.

⚠WARNING Flush unit in a well ventilated area. Eye protection is recommended. Keep face away from exhaust port.

After solvent has passed through the pump, replace the filter assemblies.

Before putting tthe pump back into service, ensure that any external accessories such as relief valves and gauges have not been damaged.

SHUTDOWN PROCEDURES

Proper shutdown procedures must be followed to prevent pump damage. Failure to do so may result in premature pump failure. The Gast Manufacturing rotary vane non-lubricated vacuum pumps and compressors are constructed of ferrous metals or aluminum which are subject to rust and corrosion when pumping condensable vapors such as water.

Follow the steps below to assure correct storage and shutdown between use:

1. NEVER oil this non-lubricated pump.
2. After using the pump, disconnect plumbing and allow the pump to run "open" for at least 5 minutes before shutdown.
3. Be sure to plug open ports so dirt and other contaminants do not enter the unit. It is now ready for shutdown or storage.

SERVICE KIT INSTALLATION

NOTE: Gast will not guarantee the performance of a field rebuilt pump. You can return the pump to a Gast authorized service facility, or perform the rebuild procedures described below.

Each service kit contains most or all of the following: bearings, vanes, gaskets, and filter elements.

SERVICE KIT INSTALLATION

Follow these general steps to install the kit:

PUMP DISASSEMBLY:

1. Disconnect the pump from the electrical power.

⚠ **WARNING** You must disconnect the pump from electrical power before servicing it. Failure to do so can result in severe personal injury or death.

2. Vent all air lines to the pump to remove pressure.

⚠ **WARNING** You must vent all air lines to the pump to remove pressure before servicing it. Failure to do so can result in severe personal injury.

3. Remove the dead end shroud, fan & fan spacer.
4. Use a wheel puller to remove the dead-end plate and bearing from the pump body; note the direction of the bevel edge on the vane. Do not damge the dowel pins between the end plate and the body. Save the bearing spacer on the dead-end of the shaft for reassembly. Remove the snap ring from the end plate. Save the snap ring, belleville springs, and washer for reassembly.
5. Remove the bearing from the dead-end plate.
6. Check the exposed surfaces of the rotor, body, and end plate for scoring. If you find no scoring, you can perform a Minor Rebuild to replace only the vanes and the dead-end bearing. If you find severe damage, perform the Major Rebuild:

MINOR REBUILD:

7. Install the new vanes supplied with the kit. Be careful to face the vane bevels in the proper direction (as noted in step 4).
8. Place end plate over the shaft with dowel pins aligned. Place bearing spacer on dead end of shaft. Place the new bearing in its bore in the dead end plate. Be careful to press only on the inner bearing race.
9. Install and tighten the pump body bolts. Install the belleville springs with the washer between them, and the snap ring.

MAJOR REBUILD:

7. Remove the drive end cap. Use a wheel puller to remove the drive end plate and bearing from the body. Do not remove or damage the dowel pins in the body. Save the bearing spacer and endplate gasket for reassembly.
8. Place one of the new bearings in its seat in the drive-end plate, then place one of the shoulder rings on the drive-end of the shaft. Using an arbor press, press the bearing onto the shaft. Be careful to press only on the inner bearing race. Tighten the pump body bolts.
9. Install the new vanes supplied with the kit. Be careful to face the vane bevels in the proper direction (as noted in step 4).
10. Perform step #8 from Minor Rebuild.
11. Install the belleville springs with the washer between them, and the snap ring. Install and tighten the pump body bolts.
12. Apply a thread-lock adhesive and start the drive end cap into its thread in the drive end plate, but do not tighten it.
13. Place a dial indicator against the dead-end of the shaft to measure axial movement. Tighten the drive end cap until the indicator show .002" to .003" of the shaft movement against the belleville springs.
14. Replace the filter elements.

TROUBLE SHOOTING GUIDE

Reason for Problem	Low Vacuum	Low Pressure	High Vacuum	High Pressure	Pump Overheating	Motor Overload
Filter dirty	X	X	at pump		X	X
Muffler dirty		X		at pump	X	X
Vacuum line collasped	X		at pump		X	X
Relief valve set too high			X	X	X	X
Relief valves set too low	X	X				
Plugged vacuum/pressure line	X	X	at pump	at pump	X	X
Vanes sticking	X	X				
Running at too high RPM			X	X	X	X
Vanes worn (replace)	X	X				
Shaft seal worn (replace)	X	X				
Dust or offset powder in pump	X	X			X	X
Motor not wired correctly	X	X			X	

APPENDIX C

DATA COLLECTION SHEETS

DATA COLLECTION SHEET
ROTARY-VANE BLOWER SYSTEM
BUILDING 8200
FORT CARSON, COLORADO

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature (° F)	Outlet Pressure (psi)	Comments	Checked by (initials)

c:\dbt\forms\blower1.xls

DATA COLLECTION SHEET
ROTARY-VANE BLOWER SYSTEM
BUILDING 8200
FORT CARSON, COLORADO

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature ($^\circ$ F)	Outlet Pressure (psi)	Comments	Checked by (initials)

c:\dbt\forms\blower1.xls

DATA COLLECTION SHEET
ROTARY-VANE BLOWER SYSTEM
BUILDING 8200
FORT CARSON, COLORADO

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature (° F)	Outlet Pressure (psi)	Comments	Checked by (initials)

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DATA COLLECTION SHEET
REGENERATIVE BLOWER SYSTEM
BUILDING 8200
FORT CARSON, COLORADO

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature ($^\circ$ F)	Outlet Pressure (inches H_2O)	Comments	Checked by (initials)

c:\dbt\forms\blower.xls

DATA COLLECTION SHEET
REGENERATIVE BLOWER SYSTEM
BUILDING 8200
FORT CARSON, COLORADO

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature (° F)	Outlet Pressure (inches H_2O)	Comments	Checked by (initials)

DATA COLLECTION SHEET
REGENERATIVE BLOWER SYSTEM
BUILDING 8200
FORT CARSON, COLORADO

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature ($^\circ$ F)	Outlet Pressure (inches H_2O)	Comments	Checked by (initials)

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